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ABSTRACT

Current social learning theory proposes that motor skill information which is acquired by means of observational strategies is stored cognitively in the form of a conceptual representation. The latter is then said to be used as a basis for response production and as a standard for response corrections which occur as a function of performance feedback. What is not known is how much of skill practice time should be spent in observation of a model as opposed to receiving response-contingent feedback. To answer this question, seven experiemental conditions, which varied in regard to amount of practice time spent either in observing a model or receiving response-contingent feedback, were used with 84 subjects. The subjects were given 60 practice trials on a barrier task prior to performing 20 no-feedback retention trials and 20 no-feedback delayed retention trials. The results of the analysis of the immediate retention effects were somewhat equivocal in terms of providing any definitive answers. Most pronounced in the delayed retention analysis were the results which indicated that four out of five conditions, which included some combination of observational learning and performance feedback, were superior to performance feedback alone. A brief list of references is included. (Author/CB)

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The Observational Learning of a Timing Skill

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Abstract

Current social learning theory proposes that motor skill information which is acquired by means of observational strategies is stored cognitively in the form of a conceptual representation. The latter is then said to be used as a basis for response production and as a standard for response corrrections which occur as a function of performance feedback (Carroll & Bandura, 1982). What is not known is how much of skill practice time should be spent in observation of a model as opposed to receiving response-contingent feedback (KR). It is this question which forms the basis of this investigation. Seven experimental conditions which varied in regard to the amount of practice time spent either in observing a model or receiving response-contingent feedback (KR) were used. Subjects (N=84) were given 60 practice trials on a barrier task prior to performing 20 no-KR immediate retention trials and 20 no-KR delayed retention (24 hr delay) trials. The results of the analysis of the immediate retention effects were somewhat equivocal in terms of providing any definitive answers. Most pronounced in the delayed retention analysis were the results which indicated that four out of the five conditions, which included some combination of observational learning and performance feedback (KR), were superior to performance feedback (KR) alone. The delayed retention data argue vigorously in favor of spending maximal amounts of practice time in model observation as opposed to physical practice.

Most recent investigations involving observational learning of motor skills have been conducted within the framework of Bandura's (1977) social learning theory. The uniqueness of this theory over earlier interpretations is its reliance on cognition as the major explanatory concept. This shift to a cognitively-based explanation of observational learning is consistent with that which also has occurred recently in other learning-based perspectives such as Schmidt's (1975) schema theory of discrete motor skill learning.

Questions concerning the nature, development, and modification of a motor program have received wide attention since cognitive interpretations of motor skill learning were advanced (e. g., Keele, 1977; Schmidt, 1975). From the current observational learning perspective, the notion of a motor program is closely linked with the construct which Carroll and Bandura (1982) refer to as a conceptual representation. From the latter point of view, observational learning of a motor skill is perceived as a process whereby the individual constructs a conceptual representation through repeated model observations in combination with some overt practice. The information which is acquired observationally is then represented cognitively in symbolic form (Bandura, 1977; Sheffield, 1961).

The conceptual or cognitive representation is hypothesized to serve a dual function: (1) it provides the cognitive template used for response production, and (2) it is used as the reference for response corrections which occur as a function of providing feedback. The conceptual representation is then said to be

modified and strengthened through repreated model observations, overt practice, and performance feedback.

In support of the social learning or, more specifically, the cognitive interpretation of the processes underlying the observational learning of motor skills, several studies have demonstrated that the transformation of observed responses into symbolic codes such as verbal labels enhances subsequent response production (Bandura & Jeffery, 1973; Bandura, Jeffery, & Bachicha, 1974). Similar results have also been found when subjects used imaginal techniques in conjunction with the observational learning manipulation (Gerst, 1971; Jeffery, 1976). Taken together, this body of evidence supports the importance of cognition and, therefore, the notion of cognitive representation within the observational learning framework.

From the cognitive perspective presented above, several variables could affect the quality of what is learned observationally. Characteristics of both the observer and the task can mediate within the observbational learning process. For instance, from the orientation of Fitts and Posner (1967), the early stages of learning motor skills require large amounts of cognitive activity on the part of the learner. This would be particularly true if effective task performance required large amounts of conceptual understandings relative to action patterns and response outcomes (Bandura, 1977) or subtle interactions or combinations of spatial and/or temporal features. (Carroll & Bandura, 1982). Under either of those conditions, observers may learn more than overt performers because they can devote their full attention to task performance parameters. On the

other hand, the attention of overt performers must be divided among aspects of response selection, execution, and performance consequences (Bandura, 1977).

It is generally accepted that some overt responding with accompanying feedback must occur, in addition to model observation, in order for the conceptual representation of a novel, complex motor skill to be modified and corrected. However, at the present time, little is known about the optimal ratio of observational versus overt practice in the learning of motor skills.

Therefore, the experimental purpose of the current investigation was to explore the relative effectiveness of several combinations of observational learning trials to performance feedback trials during the practice of a novel motor skill which required a timing response. Both immediate transfer performance and retention effects were assessed. Due to the lack of a sufficient data base, no directional hypotheses were posited.

Method

Subjects and Design

Subjects were 84 right-handed, high school females. Twelve subjects were randomly assigned to each of seven groups. The experimental manipulation was that of the relative amount of practice time spent either in observing a correct model or in overt motor responses which were followed by performance feedback (KR). Knowledge of results was provided in the form of actual movement time. Table 1 presents the seven experimental

conditions.

Insert Table 1 about here

All subjects performed 60 trials during the practice phase. The total of 60 trials was divided into 10 blocks of six trial each. In the combined treatments (conditions 2 through 6), depending on the experimental condition, the sequence of observational learning trials and performance feedback (KR) trials varied in a systematic manner. For instance, in condition 2, subjects experienced five observational learning trials followed by one performance feedback (KR) trial. While in Condition 3, subjects performed two observational learning trials followed by one performance feedback (KR) trial twice during any block of six trials. The block sequence appropriate for each condition was then repeated ten times across the total of 60 trials.

The seven practice conditions and the 20 immediate retention and 20 delayed retention trials formed two separate designs. Each consisted of a 7 (Practice Group) X 4 (Trial Blocks) factorial ANOVA with repeated measures on the last factor.

Apparatus

The apparatus was a modification of a barrier task previously used by Ross (1974). It consisted of seven barriers each positioned on a 2 ft. (60.96 cm) X 3 ft. (91.44 cm) plywood base. All barriers were 4 in. (10.16 cm) X 4 in. (10.16 cm) pieces of pressboard, hinged vertically into position by magnets. Behind each barrier was a 4 in. (10.16 cm) X 3 in. (7.62 cm) X

1/4 in. (.635) piece of foam rubber. The foam rubber was used to reduce the sound associated with displacing the barrier. Two microswitches, attached to an electronic 1/1000 sec. clock were used to start and stop the clock. Figure 1 simulates the

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Insert Figure 1 about here

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location of the seven barriers, the two microswitches, and the direction (e. e., right -left or left-right) and order (barriers 1-7) which had to be used in order to complete the prescribed patterns. The apparatus was secured to a table of normal height. Subjects sat in front of the apparatus, while the experimenter was situated outside the subject's visual field. The object of the task was to complete the pattern correctly in exactly 2,100 msec. The 2,100 msec criterion was used for all phases of the experiment.

Procedure

All subjects received 60 practice trials. The intertrial interval was 15 sec. KR (in the form of actual movement time) was provided 6 sec. after each overt performance trial. The total time spent by all subjects during the practice phase was identical across all conditions. Following a 5 min. rest, 20 no-KR trials were performed. After a 24 hr. interval, all subjects returned to perform 20 additional no-KR trials.

Subjects assigned to any of the six observational learning conditions saw a video-taped playback of a female, similar-aged, model perform the barrier task at criterion (2,100 msec). The

stimulus consisted of a close-up view of the seven barriers, a hand resting on the starting microswitch, followed by the hand moving through the prescribed pattern in which the barriers were displaced in order. The stimulus presentation concluded with a voice on the video-tape which said, "2,100 msec., that is correct." The modeling stimulus contained the auditory and visual components of the task. Therefore, the observers could both hear the barriers fall and see the model's movement.

The 100% physical practice group did not view any video-tape playback, however, they were shown a diagram, prior to the practice phase, which depicted the requied movement pattern. Tape-recorded instructions informed all subjects of the experimental procedure and the task criterion.

When the experimenter gave the cue "ready," the subject placed the right hand directly on the microswitch located in the front portion of the apparatus. Two sec later, the experimenter gave the command "go" and the subject began the trial. The trial was terminated when the subject successfully completed the prescribed pattern and displaced the seventh barrior. The displacement of barrior seven stopped the clock. Upon completion of a trial, all barriers were returned to the up-right position.

Results

Absolute error (AE) was used as the dependent measure as it was deemed most suitable for making comparisons with other similar research investigations (Doody, Bird, & Ross, Note 1;

Ross, Bird, Doody, & Zoeller, Note 2)[1]. Separate variance analyses were conducted for the immediate transfer and retention data.

Immediate Retention

The 7 (Practice Group) X 4 (Trial Blocks) variance analysis indicated significant main effects for both Practice Group, $F(6, 1652) = 13.69$, $p < .0001$ and Blocks, $F(3, 1652) = 3.48$, $p < .05$. The Practice Group X Blocks interaction also reached significance, $F(18, 1652) = 3.03$, $p < .001$.

The effect of theoretical interest was that of the main effect for Practice Group. Therefore, Tukey (hsd) multiple comparisons were conducted to determine any differences among overall Practice Group means. Figure 2 presents the Practice Group means graphically[2].

Insert Figure 2 about here

Results indicated that the 100% observational learning group performed significantly worse as compared to all other groups. Within the combined observational learning-performance feedback conditions, the group which practiced under conditions of a ratio

[1] The results of the analyses for CE and VE are available upon request.

[2] The results of all Tukey (hsd) multiple comparisons (i. e., for both immediate and delayed retention) are available upon request.

of 50% observational learning to 50% performance feedback demonstrated significantly more error than all other combined treatments with the exception of the minimal modeling group (16.7%). The only other significant differences within the combined conditions were those which indicated that the minimal observational learning group (16.7%) performed significantly worse as compared to the two maximal modeling groups (i. e., 66.6% and 83.3%). The 100% performance feedback treatment was significantly better than the 100% observational learning group and also significantly worse than the 83.3% observational learning condition.

Taken together, these results argue for the superiority of observational learning over performance feedback only under conditions of maximal observational learning. To determine if the latter was a stable influencing effect, no-KR transfer data were collected after a 24 hr retention period.

Delayed Retention Effects

The 7 (Practice Group) X 4 (Trial Blocks) variance analysis for absolute error for the 24 hr retention data indicated only a single significant effect. Performance differed as a function of Practice Group, $F(6, 1652) = 13.13$, $p < .0001$. To isolate the origin of this effect more precisely, Tukey (hsd) multiple comparisons of the mean absolute error for all Practice Group means were conducted. Figure 3 presents those delayed retention effects in graphic form.

Insert Figure 3 about here

One striking result of that analysis was that which indicated that after the delayed (24 hr) retention period, all of the combined observational learning-performance feedback groups demonstrated significantly less error as compared to the 100% performance feedback treatment with only one exception, the minimal modeling condition (i. e., the 16.7% modeling group). That result provides strong support for the efficiency of observational learning, in sufficient amounts, over the usual KR treatment. Again, the 100% observational learning condition was significantly worse than all other treatments. The negative effects on motor performance generated by the 50:50 (observational learning:performance feedback) treatment evidenced in the immediate transfer effects was not replicated after the 24 hr delay, as this condition was not significantly different from any of the other combined groups with the exception of the minimal observational learning group (i. e., 16.7% modeling).

Discussion

It was not surprising that total exposure to a model accompanied by no overt practice was not as effective as was all overt practice accompanied by performance feedback (KR). Obviously, the 100% observational learning group had no opportunity to execute the desired response and, thus, to modify the conceptual representation on the basis of the performance feedback (KR). This finding is in agreement with social learning theory which would predict that some overt responses must accompany the observational learning strategy in order for performance facilitation to occur (Bandura, 1977; Carroll &

Bandura, 1982).

The results of the analysis of the immediate retention effects were rather ambiguous in terms of identifying any clearcut answers relative to an optimal combination of observational learning and performance feedback (KR). Both the minimal modeling group (16.7%) and the equal percentages group (50% modeling, 50% performance feedback) had greater amounts of error as compared to all other combined groups.

Of greater interest in terms of inferring learning effects is the analysis of the delayed retention data. Those data argue vigorously for the effectiveness of more than minimal amounts of observational learning in combination with KR. Apparently, only relatively small amounts of overt practice (KR) may be necessary, if sufficient degrees of observational learning are available. Those results also lend strong support for the cognitive interpretation of the observational learning process. It would appear that subjects are able to develop a conceptual or cognitive representation of a motor task through observational strategies and need only rather small amounts of overt practice in conjunction with performance feedback in order to make response corrections. The finding that the 100% observational learning group improved only slightly between immediate and delayed retention tests indicates that movement information in the absence of performance-based KR is not sufficient to improve the conceptual representation of the task.

The differences indicated between the immediate and the delayed retention data also demonstrate that subjects can store, modify, and retrieve observationally-derived information.

Clearly, those are cognitively-based activities. Therefore, taken as a whole, the delayed retention results provide rather impressive substantiation for a cognitive explanation of the processes underlying the observational learning of motor skills.

In closing, it should be noted that since the task which was used in the current investigation involved a primary timing component, the results would appear to be limited in generalizability to similar tasks. For instance, tasks which have a primary strength or motor component, as opposed to a strong cognitive component, would probably not generate such powerful observational learning effects (Feltz & Landers, 1983; Ryan & Simmons, 1983). Further research is also needed concerning the relative effectiveness of observational learning for motor tasks which vary in their degree of spatial, temporal, and force demands.

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Table 1

Practice Regime of the Seven Experimental Conditions

Condition	Percentage of O. L.* of six trials	Percentage of P. F.**	Sequence of O. L. followed by P. F. trials in any block of trials
1	100	0	6-0
2	83.3	16.7	5-1
3	66.6	33.4	2-1, 2-1
4	50	50	1-1, 1-1, 1-1
5	34.4	66.6	1-2, 1-2
6	16.7	83.3	1-5
7	0	100	0-6

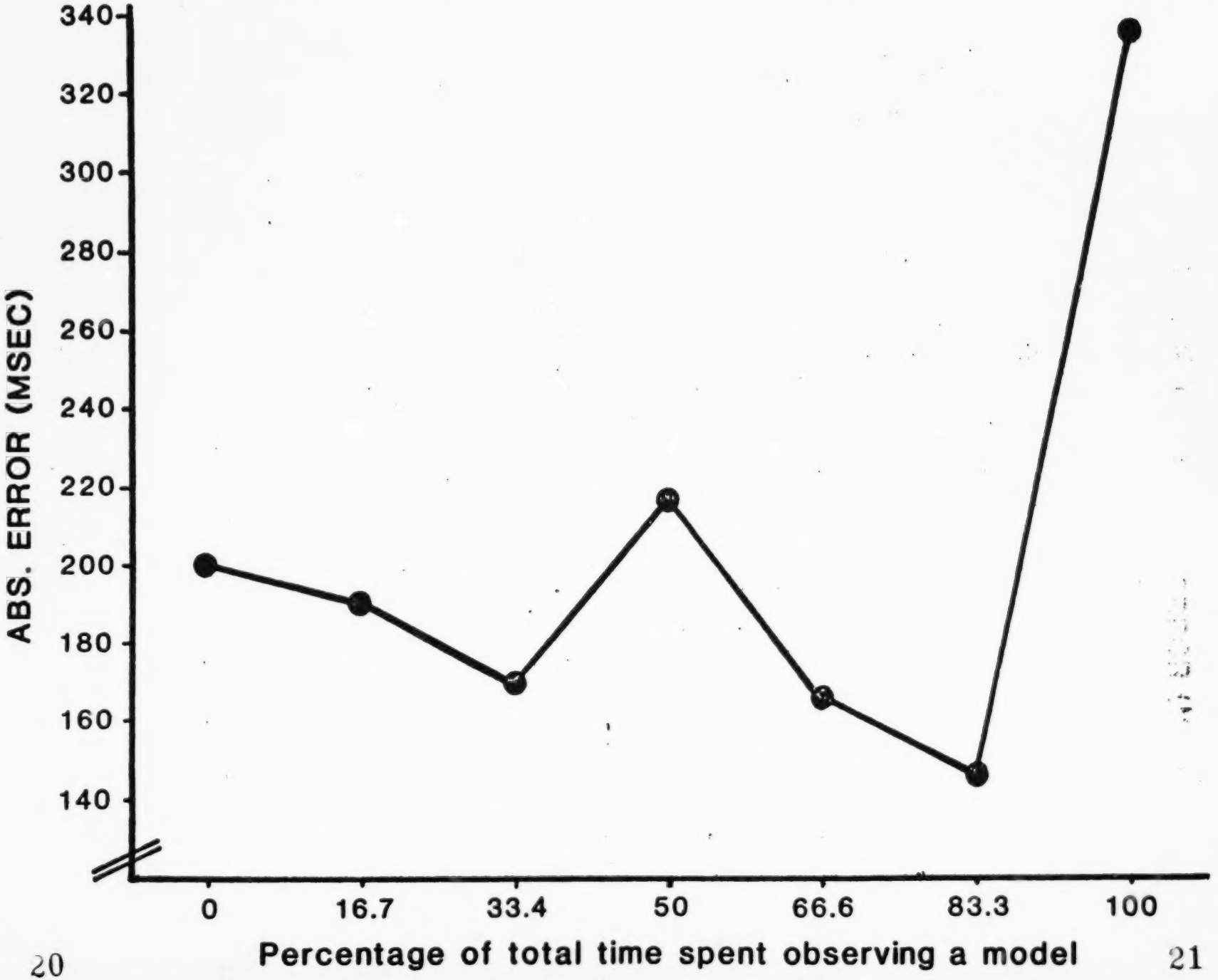
* O. L. = Observational Learning
**P. F. = Performance Feedback (KR)

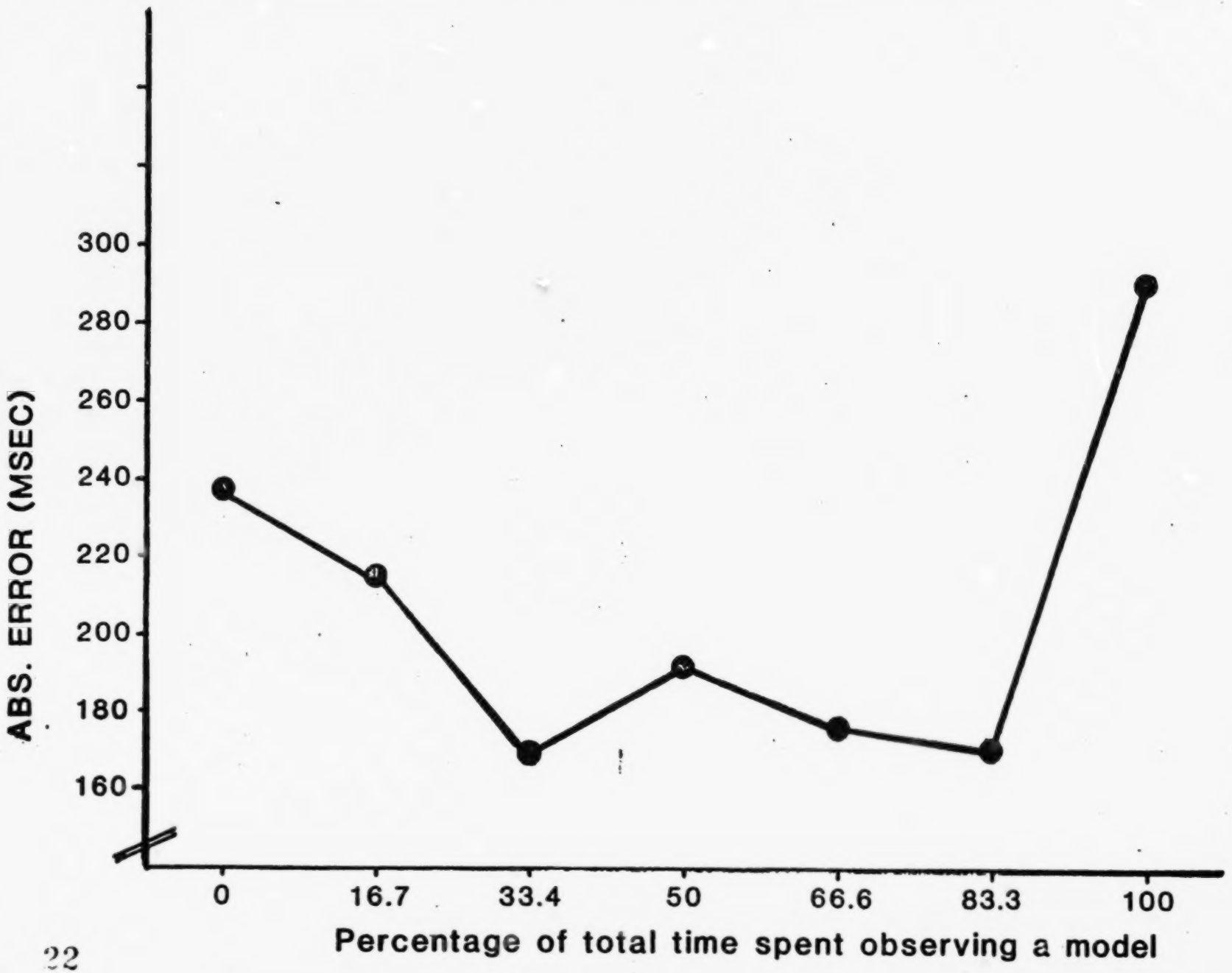
Figure Captions

Figure 1. Simulation of barrior task

Figure 2. Immediate Retention effects

Figure 3. Delayed Retention effects


340
320
300
280
260
240
220
200
180
160
140
ABS. ERROR (MSEC)
0
16.7
33.4
50
66.6
83.3
100
Percentage of total time spent observing a model


ABS. ERROR (MSEC)
300
280
260
240
220
200
180
160
0
16.7
33.4
50
66.6
83.3
100
Percentage of total time spent observing a model